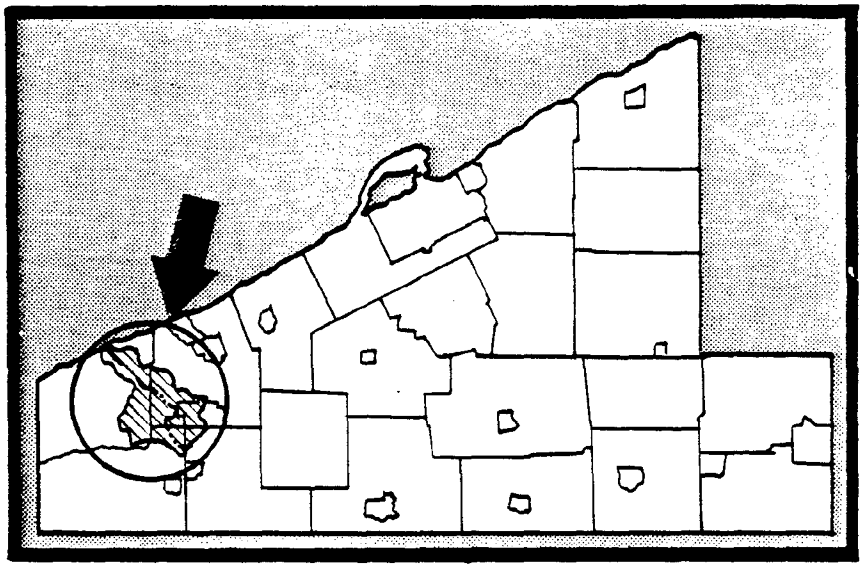
STORM WATER MANAGEMENT PLAN



CROOKED CREEK VOLUME 11

ERIE COUNTY DEPARTMENT OF PLANNING
COMMONWEALTH OF PENNSYLVANIA

OCTOBER 1981

PREPARED BY

NORTHWEST INSTITUTE OF RESEARCH - WOODRUFF, INC.

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This study was financed through a planning assistance grant from the National Oceanic and Atmospheric Administration as administered through the Pennsylvania Department of Environmental Resources Coastal Zone Management Office (Office of Resources Management), and the Erie County Department of Planning.

STORM WATER MANAGEMENT PLAN

CROOKED CREEK WATERSHED

Volume 11

Prepared For

Commonwealth of Pennsylvania

Department of Environmental Resources

and

Erie County Department of Planning

Prepared By

Northwest Institute of Research - Woodruff, Inc.

As a Consortium

October 1981

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Section 1

SUMMARY AND RECOMMENDATIONS

This document has been prepared in accordance with the provisions of the Pennsylvania Storm Water Management Act, P.L. 864, Act 167, October 4, 1978 and is a pilot study under that Act. The Northwest Institute of Research of Erie, Pennsylvania and Woodruff Incorporated, Consulting Engineers of Cleveland, Ohio have formed a consortium for the purpose of developing a pilot storm water management plan for the Lake Erie and Elk Creek Watersheds. This study has been prepared under the direction of the Pennsylvania Department of Environmental Resources, Bureau of Dams and Waterway Management, Division of Storm Water Management and the Erie County Department of Planning.

This report is Volume 11 in a series of 14 volumes prepared for the Erie County Department of Planning. The purposes of this report are:

1. To establish as base conditions the existing land use and the existing storm water runoff in the Crooked Creek Watershed against which future conditions can be compared.
2. To calculate the runoff from a projected land use to indicate how much more flow the main stream and its branches would be required to carry.
3. To present a set of criteria and standards for storm water management in this watershed.
4. To recommend the one or more alternative storm water management methods best suited to the needs of the Crooked Creek Watershed.

The standards and criteria which are to be applied to storm water runoff have been summarized in Section 4 and are described in complete detail in Volume 1. It is recommended that these standards and criteria be adopted by the committee in the Crooked Creek Watershed Area.

The various means of implementing these standards and criteria are discussed in Section 5. It is recommended that the on-site approach to storm water management as described in Section 5 be adopted immediately and included in all future development plans. Immediate steps are to be taken so that the Crooked Creek Watershed Area will be prepared for the tremendous growth that will occur should the U.S. Steel proposal for Springfield Township come to fruition.

It should be emphasized that this storm water management plan is intended solely to minimize the creation of new flood problem areas as a result of increased runoff due to development. Also, existing problem areas will not be aggravated by increased runoff. In this way, the municipalities will be able to concentrate on solutions for those flooding problems that presently trouble local property owners.

Section 2

BACKGROUND

The basic approach to storm water management in the past has been to achieve maximum convenience at an individual site by getting rid of any excess surface water after a rainfall as quickly as possible. This removal is accomplished typically by disposal of the water through a storm sewer or other closed system. As the land in a given area becomes more and more developed, this policy has led to the following problems:

1. Flooding due to overland flow.
2. Increasingly frequent downstream flooding.
3. Diminished groundwater supplies.
4. Erosion of stream banks.
5. Siltation and pollution of streams.

As land development continues, the percentage of impervious land surface increases as paved roads, sidewalks, parking lots, and other structures are built. The result of this change is to further aggravate the problem. Areas that previously had no flooding begin experiencing problems and areas which might have been prone to flooding earlier now experience an even more severe problem.

The solution of passing one's own water problems downstream is no longer acceptable. The potential damage created by such an approach cannot be tolerated as developments continue to move into once rural areas.

Clearly, a new approach to handling storm water runoff is needed. A storm water management plan is necessary that protects our land and streams as well as permits reasonable development. The new approach must strike a balance between local convenience and protection against the hazard of flooding. One significant feature of the approach presented in this document will be the planned detention of water on-site in various types of storage facilities. Such structures will hold the water and release it slowly over time, after the danger of flooding is past. In the process, downstream areas will be protected.

This concept will be discussed more fully in the following pages and will be applied to the specific requirements of the Crooked Creek Watershed.

Section 3

DESCRIPTION OF THE CROOKED CREEK WATERSHED

On Plate No. 11-1[1] the base map for the Crooked Creek Watershed Area is presented. On this map, major topographic features of the watershed are shown. The Crooked Creek Watershed is located in the townships of Springfield, Conneaut, Elk Creek, Platea and Girard. It covers an area of approximately 12,000 acres. There are numerous wetlands located in the Crooked Creek Watershed. Large concentrations of prime and unique agricultural soils are located within this region. Crooked Creek is classed as an environmentally sensitive area due to the steep escarpments which border both sides of the stream corridor from where it flows in Springfield Borough to its mouth at Lake Erie. Thus, it becomes very important to prevent future damage from flooding and erosion caused by storm water runoff.

3.1 Local Input Data

There are five types of local data which have been considered in the description of the Crooked Creek Watershed Area. These include:

1. Significant obstructions
2. Existing drainage problems
3. Location of existing storm sewers
4. Proposed storm sewers
5. Existing and proposed flood control projects

Each of these types of data are discussed in the following paragraphs. This information is as complete as possible at the time of writing. Additional information may be added as it becomes available.

3.1.1 Significant obstructions

A significant obstruction is defined as any structure or assembly of materials which might impede, retard or change the flow of storm water runoff.

Significant obstructions in the Crooked Creek Watershed were located both by surveys conducted by the consultant and by local input from municipal and county officials as well as the Advisory Committee composed of representatives from the affected municipalities. Those obstructions which were identified are described on Table 11-1 and located on the map presented on Plate No. 11-2.

A total of 14 obstructions were mapped. These include many bridge abutments and piers or culverts through which the main stream or side branches pass as they flow under highways, driveways and railroads. While many of these structures do not obstruct normal flow, all may be considered potentially obstructive during severe storms if debris is allowed to collect in culvert openings or around bridge piers. They also serve as potential entrapments for ice floes.

(1)For the convenience of the reader and to facilitate locating of tables and maps, all of these illustrations are placed in order in Appendix A at the end of this report.

The importance of these obstructions is obvious since anything which interferes with the natural flow of the stream can contribute to local flooding under storm conditions. The control of increased runoff due to development that would result from the implementation of this storm water management plan will insure that these structures will operate hydraulically at their present levels. Thus, if a particular structure has no recurrent problems in passing stream flows at the present time, no problems would be expected in the future under the plan as development proceeds. Flooding problems due to structures of insufficient hydraulic capacity will not get worse in the future, nor will they be eliminated by the institution of these storm water management policies. The intent of this plan is to maintain the status quo regarding stream flow.

3.1.2 Existing drainage problem areas

There were 18 drainage problems identified in the Crooked Creek Watershed as indicated in Table 11-2 and shown on Plate No. 11-3. One problem involves the flooding of a culvert inlet during severe rainstorms. This problem is located at the point where Crooked Creek intersects with Gloskey Road.

The solutions to this particular problem are listed as increasing the size of the culvert, increasing channel capacity and/or constructing an upstream retention facility. Caution must be taken when incorporating these or any other solutions to insure that no flooding problems are created downstream.

As other drainage problems are identified in the Crooked Creek Watershed Area, they can be added to Table 11-2 and Plate No. 11-3.

3.1.3 Existing storm sewers

The third type of local input involved the location of all existing storm sewers in the Crooked Creek Watershed Area. This information has not yet been completed. These data can be obtained by consulting the comprehensive plans for Springfield, Conneaut, Elk Creek, Platea and Girard Townships. Plate No. 11-4 is provided so that the location of any additional structures may be mapped.

At the present time, barring evidence to the contrary, the assumption is made that none of these storm sewers has a significant impact on the management of storm water in this area.

3.1.4 Proposed storm sewers

Tables 11-3, 11-4 and 11-5 are provided for the purpose of listing and locating all proposed storm sewers in the Crooked Creek Watershed Area. At the time of writing this report, no new storm sewers are known to have been proposed for the Crooked Creek area. The tables are provided so that information can be added to them and Plate No. 11-4 as it becomes available.

3.1.5 Existing and proposed flood control projects

Plate No. 11-5 and Tables 11-6 and 11-7 are provided for the purpose of entering the location and description of all existing and proposed flood control projects. At this time, there are no known flood control projects in the Crooked Creek Watershed Area. Additional information can be added to these maps as it becomes available.

3.2 Present and Projected Land Use

Present land use is shown on Plate No. 11-6. Existing land use data was taken from the Erie County Land Use Plan Update (June, 1978).

It can be seen from the existing land use map that the area is at present generally undeveloped, with large portions of open, wooded and cultivated areas. There are a few, widely-spaced pockets of residential use.

The potential development of this area is illustrated on the ultimate land use map (Plate No. 11-7). This projected land use map indicates major residential development, some of which is also agricultural. In addition, small areas of commercial use are indicated.

3.3 Soil Types

The various soil types found within the Crooked Creek Watershed Area are shown on Plate No. 11-8. These soils include the following:

1. Silty and clayey soils, chiefly on the lake plain (Wallington-Birdsall-Williamson and Collamer).
2. Gravelly and sandy soils of the beach ridges (Conotton-Ottawa-Fredon).
3. Sandy soils of the lake plain (Rimer-Wauseon-Berrien).

3.4 The National Flood Insurance 100-Year Flood Plain

The 100-year flood is defined as the highest level of flooding that is likely to occur on the average, every 100 years. The fact that an area has not flooded recently does not mean it will not do so in the future. The probability of such an occurrence is 1 percent in any given year.

The Flood Plain Management Act, Act 166, October 4, 1978, prohibits development within designated flood plains. No development is allowed in any areas 50 feet or less from the boundaries of designated flood plains. This is intended to reduce flood damage and accumulation of debris due to the 100 year flood and is consistent with the intent of the Storm Water Management Act.

On Plate No. 11-9, the flood plain for the basic or 100-year flood is shown. The information was taken from the National Flood Insurance Program Maps (Available for reference at the Erie County Planning Department office).

Section 4

STANDARDS AND CRITERIA FOR STORM WATER MANAGEMENT

The following are the recommended standards and criteria for storm water management in the Crooked Creek Watershed Area. A complete derivation and justification of these standards are to be found in Volume 1 of this study report. The recommended standards and criteria may be completely satisfied by use of the on-site approach discussed in Section 5 of this volume.

The most fundamental standard of this study is that the amount of flow along Crooked Creek must not be allowed to increase at the data points labeled "A" through "I" on Plate No. 11-10 above those existing flows indicated on Table 11-8 for each of these points. These flows were obtained from a computer model developed expressly for Crooked Creek using the design storm described below. Flows at positions between the given points must not exceed a straight line interpolation of flow values at adjacent points. This will insure that the flow characteristics of Crooked Creek will remain at their 1981 level for storms equal to or less than the design storm. The objective is to maintain the existing level of flow in the main stream channel for the design storm and to maintain bank-full capacity for the side branches. A policy such as this will not only effectively manage increased runoff as desired, but will help to maintain the sensitive ecological balance of the stream.

4.1 Definition of Design Storm

The design storm for this study has been determined to be the 10-year, 24-hour storm. The choice of this storm is justified in Volume 1 of this study. The 10-year, 24-hour storm is that theoretical storm of 24-hour duration that statistically will occur once in 10 years. On the average such a storm would produce 4.8 inches of rain in a 24-hour period. As previously mentioned, this is the storm used to derive the magnitude of flow at the data points described above.

4.2 Definition of Type 1 and Type 2 Channels

Because some of the channels that make up the Crooked Creek drainage systems are more able to carry increased flows than are others, two sets of criteria and standards have been devised for two types of channels. The first, or Type 1 Channels, are characterized as main stream channels. They have a well-defined flood plain and can handle increased flows very easily. These are the shaded portions of the Crooked Creek drainage system shown on Plate No. 11-9, "The One-Hundred-Year Flood Plain." The second are referred to as Type 2 channels. These consist of all the other portions of the Crooked Creek drainage system that are not shaded on Plate No. 11-9. They are characterized as branch stream channels. Plate No. 11-10, the Subwatershed Map for Crooked Creek, indicates those portions of the watershed area whose runoff is initially discharged into Type 1 Channels and those whose runoff is initially discharged into Type 2 Channels.

4.3 Criteria for Type 1 Channels (Main Stream)

For those sites which are to discharge their runoff into a Type 1 Channel, it will be required that the increased runoff after development (due to the design storm) be managed by any of the recommended on-site methods discussed in Section 5. That is to say, the runoff due to the 10-year, 24-hour storm is to be calculated again for the same storm taking into account the specific proposed development. The difference between these two runoffs is that which must be managed.

4.4 Criteria for Type 2 Channels (Branch Streams)

For those sites which are to discharge their runoff into a Type 2 Channel, a more stringent standard is to be applied. This is necessary because these channels typically are too small to accommodate increased runoff. They have no flood plain to act as a cushion.

In this situation, the amount of storm water that must be stored is the difference in runoff between that due to proposed land use for the 10-year, 24-hour storm and that due to the mean annual storm for existing land use conditions. As defined previously, the mean annual storm [1] is calculated by taking the largest storm for each year on record and averaging them together. Statistically, the mean annual storm is equivalent to a storm with a return frequency of 2.33 years. Whereas side branches are naturally formed to handle the more frequent mean annual storm, this more stringent criterion would now protect them against flooding for all storms up to and including the 10-year, 24-hour storm.

[1]The concept of a mean annual storm was developed by L. Leopold and referenced in Storm Water Management, 1980.

Section 5

IMPLEMENTATION

5.1 Introduction

Every parcel of land has unique storm water runoff characteristics which inevitably change when the parcel is developed, usually resulting in an increase in storm water runoff from the site. When development takes place the increase in storm water runoff is magnified and serious problems can result. Prior to the development of this Plan there was no established method through which a municipality could require developers to take precautions against causing storm water runoff problems. The purpose of this Plan is to help correct the situation by establishing standards for storm water management and an administrative procedure whereby those standards can be applied by local governments to development within their jurisdiction.

The Storm Water Management Plan will be implemented by individual municipalities through the adoption of a storm water management ordinance or through amendments to existing subdivision or zoning regulations. Administration of the storm water management program will be accomplished through a combination of enforcement actions undertaken through the building permit process and through the subdivision review process, both of which are detailed later in this Section.

5.2 Special Considerations

Prior to discussing the specifics of the Building Permit Process and the Subdivision Review Process, two subjects which fall outside of the scope of this Plan's evaluation procedures will be discussed. The Building Permit and Subdivision Review evaluation procedures for storm water management apply to all forms of development and land use except development in areas with an existing storm sewer infrastructure and with respect to agricultural land.

In situations where development or redevelopment occurs in an area where direct access to an established storm sewer infrastructure is possible, the development or redevelopment is considered sufficient to manage its storm water runoff if its on-site storm drainage network is incorporated into the existing storm water infrastructure. By connecting with the existing storm sewer system, the development would be relieved of further obligations to manage storm water runoff in accordance with this Plan unless the municipal governing body perceives a potential storm water drainage problem or if the governing body wishes to correct an existing storm drainage problem. In these cases where the governing body desires a more stringent application of storm water management controls they may require that a detention/retention plan be developed which would alleviate the storm water drainage problem.

Evaluating agricultural land for compliance with storm water management controls is the second topic which falls outside of the scope of the Building Permit and Subdivision Review procedures. With respect to agricultural land, the recommended method of storm water management is to have a Soil Erosion and Sedimentation Control plan and/or permit prepared in accordance with existing State law and reviewed by the Erie County Soil Conservation Service. This applies only to cultivated land; agricultural accessory structures and residential structures should be evaluated by the municipality through the applicable method as outlined in the following sections.

5.3 Building Permit Process

If a proposed subdivision is defined by the host municipality's subdivision regulations as a minor subdivision (usually 10 lots or less) or if development is proposed involving no subdivision of property, then storm water management standards and criteria should be evaluated at the time when development is formally proposed via an application for a building permit. This system is designed so that smaller developments may occur without incurring added engineering expense and so that municipalities can implement storm water management requirements without incurring substantial administrative overhead expense.

The recommended technique to be followed when evaluating a minor subdivision or a development on an existing lot of record is presented here. First, all developments which fall into the above categories must meet each of the following:

Standard Controls

1. Roof drains are not to be connected to streets, sanitary sewers or roadside ditches.

2. Runoff from the impervious areas must be drained to the pervious areas of the property.

3. Runoff is not to be collected or concentrated into an artificial conveyance and discharged onto adjacent property.

Next, the zoning officer must calculate the percentage of the parcel which will be covered by impervious surfaces after development is concluded. In this context impervious surfaces mean all land covered by a house, barn, garage, patio, driveway, etc. Information needed to calculate the percentage of impervious area should be readily available on the building permit application. Once the calculation is made the zoning officer should refer to the following table to determine how many storm water controls in addition to those listed above will be needed to comply with the standards of the Storm Water Management Plan. The additional controls can be found in Table 11-9.

Determination of Controls

Less than 15% impervious	Standard controls only
15% - 19.99% impervious	Standard controls only plus one additional control
20% - 24.99% impervious	Standard controls plus 2 additional controls
25% - 30% impervious	Standard controls plus 3 additional controls

The methodology outlined above is designed to be used for a proposed development which covers 30% or less of the parcel with an impervious surface. Under such circumstances the zoning officer can show the potential developer what storm water management controls are needed in order to receive this building permit. If the proposed development will cover greater than 30% of the parcel with an impervious surface or if the total impervious area exceeds one acre, then a licensed professional must be consulted to prepare a detention/retention plan which meets the approval of the governing body. An additional fee is recommended to be added to the existing building permit fee to cover the expense of administering the program.

5.4 Subdivision Review Process

If a development is defined by the host municipality's subdivision regulations as a major subdivision (usually more than 10 lots), the storm water management standards and criteria should be evaluated during the subdivision review process. This use of the subdivision review process is designed to ensure that large scale developments employ proper techniques to control storm water runoff and that these controls are firmly established prior to municipal or county approval of the subdivision plat. When a preliminary major subdivision plan is submitted for municipal review it shall be accompanied by detailed storm water detention/retention specifications which meet the criteria of the Plan and which have been prepared by a professional licensed to perform such work in this Commonwealth. The proposed storm water detention/retention specifications shall be reviewed by the municipality and/or its engineer and shall satisfy the municipality before the major subdivision plan is approved. The municipality may require controls which are more stringent than those which meet the Storm Water Plan's criteria if circumstances dictate that such measures are needed to alleviate a current drainage problem or a suspected future drainage problem.

5.5 Conclusion

The Lake Erie and Elk Creek Storm Water Management Plan has been developed in accordance with Act 167 of 1978, the Pennsylvania Storm Water Management Act. Under the provisions of this Act, municipalities are granted certain powers and must assume certain responsibilities. One of the responsibilities which has been assigned to local governments by the Act is the responsibility to adopt implementing ordinances such as those described in this section. Another responsibility assigned to the municipality is that of properly enforcing the storm water management ordinances and regulations. Because of the responsibilities awarded to municipalities under Act 167, each municipality affected by this Plan should consult their municipal solicitor for a briefing about the extent of their obligations under the provisions of Act 167.

Section 6

THE CROOKED CREEK COMPUTER MODEL

As has been discussed previously, a computer model of the Crooked Creek drainage system was developed for the purpose of this study. A complete description of the background and development of this computer model is given in Volume 1 of this report. The following is a summary of the data used as input for the model and a description of the data it yielded as output.

6.1 Existing Stream Characteristics

The existing land use for the Crooked Creek Watershed Area is shown on Plate No. 11-6. This is a base land use against which future development is to be compared upon adoption of this storm water management plan. It can be seen that the area is generally undeveloped. There are large areas which are open, wooded or cultivated.

The runoff due to this land use was entered into the computer model. A soil factor derived from the various types of soils found in the Crooked Creek Watershed Area, as shown on Plate No. 11-8, was also taken into account. The results of the computer output are summarized on Table 11-8. The flow characteristics of Crooked Creek due to the runoff from existing land use are shown in the first columns labeled "Existing Runoff" for various data points. These data points are located on Plate No. 11-10. These are the flow characteristics of the stream which must not be altered due to the development of land in the watershed area.

6.2 Post-Development Stream Characteristics

A projected ultimate land use for the Crooked Creek Watershed Area was taken from the Erie County Land Use Plan Update (June, 1978). It is shown on Plate No. 11-7. This projection assumed that all of Erie County would develop to its maxmum potential, as it would if U.S. Steel were to build the large steel producing facility it has proposed for Springfield Township. Because of its location the area would lend itself to major residential development as shown.

The runoff due to this projected land use was entered into the computer model. Again, a soil factor was taken into account. The resultant flow characteristics at the data points are shown in the column labeled "Ultimate Runoff" in Table 11-8.

It can be seen that the peak flow of the ultimate runoff is considerably higher at all points than is that of the existing runoff. At the outlet to Lake Erie, the peak flow is calculated to be 4,528 cubic feet per second (cfs) for existing runoff and 5,532 cfs for ultimate runoff.

The depth of the ultimate flow is substantially higher at all data points. The increased depth becomes more critical in upstream reaches of the stream because the banks tend to be smaller in these areas. This implies a greater need for control in upstream and branch stream locations.

The velocity of the flow can also be seen to be much higher for ultimate runoff than for existing runoff. This is an undesirable situation that could result in excessive erosion of the stream bed. The stream channels would eventually widen and deepen beyond their present limits and possibly interfere with development along their banks. Foundations for bridges, culverts or retaining walls might be undermined due to a process known as scour. Scour is the washing away of earth around the footings of piers, bridge abutments retaining walls or the like, and in the process, exposing them. This reduces their structural stability.

Water quality would decline due to the inordinant amount of soil particles being carried along by the current. Development would decrease the absorption of rainfall due to the amount of impervious cover it would probably bring with it. This could lower the groundwater table to unacceptable levels.

The COWAMP Study Area 7 Report, prepared by the Department of Environmental Resources of the Commonwealth of Pennsylvania does not reveal any of the above to be current problems for the Turkey Creek Watershed Area. This makes it very important to maintain existing water quality standards related to storm water runoff.

In addition, the Clean Streams Law of Pennsylvania regulates activities that affect any stream in the Commonwealth in order to preserve and improve the purity of their water. The Storm Water Management Act will aid in the attainment of these objectives. All work done to manage storm water must be done in compliance with these rules and regulations.

APPENDIX A

TABLES AND PLATES

SIGNIFICANT OBSTRUCTIONS

NO.	MUNICIPALITY	TYPE OF STRUCTURE	DRAINAGE AREA SQ. MI'S.	CAPACITY (C.F.S.)	DATE BUILT		OWNER AND ADDRESS
	CROOKED CREEK						
1	Conneaut	Concrete Culvert, 8'x4'					
2	Conneaut	Concrete Culvert, 10'x5'					
3	Girard	Concrete Culvert, 10' and 8'x6'					
4	Girard	Elliptical CMP, 20.5'x12.5'					
5	Girard	Concrete Culvert, 15' and 26'x17'					Pennsylvania Department of Transportation
6	Girard	Concrete Culvert 25'x10'					
7	Girard	Stone Arch, 15'x12'					
8	East Springfield	Concrete Arch Culvert, 38'x24'					Pennsylvania Department of Transportation
9	East Springfield	Concrete Box, 12'x12'					Norfolk & Western Railroad
10	East Springfield	2 Elliptical C.M.P.'S, 20'x12'					
11	Springfield	Concrete Bridge (Arch), 26'x16'					Pennsylvania Department of Transportion
12	Springfield	Concrete Stone Arch, 21'x15'					Consolidated Rail Corp. 6 Penn Center Plaza Philadelphia, Pa.
13	Springfield	Steel Bridge 30'x10'					
14	Springfield	Wood and Steel Bridge, 48'x10'					

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PLAN NO.

STORM DRAINAGE PROBLEMS

NO.	LOCATION	MUNICIPALITY	PROBLEM	PROPOSED SOLUTION
1	Gloskey Road, Crooked Creek	Girard Township	Flooding at Culvert Inlet During Severe Rainstorm	Increase Culvert Size, Increase Channel Capacity or Construct Upstream Retention Facilities

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TABLE II-2

PLAN NO.

PROPOSED STORM WATER COLLECTION SYSTEMS

NO.	LOCATION AND MUNICIPALITY	CONSTR. DATE	ESTIMATED COST	SYSTEM CAPACITY CFS. / FREQ	FINAL OWNERSHIP AND MAINTENANCE RESPONSIBILITY	MAP / ITEM REFERENCE NUMBER

NOT APPLICABLE

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CROOKED CREEK

TABLE 11-3

PLAN NO.

STORM WATER COLLECTION AND CONTROL FACILITIES

PROJECT NO.	LOCATION	TYPE OF FACILITY		METHODS OF FINANCING (ALL PHASES)	FINANCIAL LIABILITY

NOT APPLICABLE

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TABLE II-4

PLAN NO.

PROJECT DEVELOPMENT AND CONSTRUCTION SCHEDULE AND COSTS

PROJECT NO.	SCHEDULE					ESTIMATED COSTS					
	DESIGN	RIGHT-OF-WAY	BIDDING	CONSTRUCTION START	CONSTRUCTION FINISH	DESIGN	RIGHT-OF-WAY	ADMINISTRATION	CONSTRUCTION	FINANCE CHARGES	MAINTENANCE (ANNUAL)
						$	$	$	$	$	$

NOT APPLICABLE

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SWM 259
CROOKED CREEK

TABLE 11-5

PLAN NO.

EXISTING FLOOD CONTROL PROJECTS

NO	PROJECT LOCATION AND MUNICIPALITY	DATE BUILT	BUILDER	PRESENT OWNER	CAPACITY	LIFE EXPECTANCY (YRS)

NOT APPLICABLE

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SWM 25:9
CROOKED CREEK
TABLE 11-6

PLAN NO

PROPOSED FLOOD CONTROL PROJECTS

NO	PROJECT LOCATION AND MUNICIPALITY	COMPLETION DATE	BUILDER	FINAL OWNER	CAPACITY (C.F.S.)	LIFE EXPECTANCY (YRS.)

NOT APPLICABLE

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TABLE 11-7

WATERSHED RUNOFF DATA

LOCATION	EXISTING RUNOFF					ULTIMATE RUNOFF					ULTIMATE RUNOFF WITH STORAGE				
	PEAK FLOW C.F.S.	TIME OF PEAK HR.	DEPTH FT.	VELOCITY F.P.S.	VOLUME MIL. CU. FT.	PEAK FLOW C.F.S.	TIME OF PEAK HR.	DEPTH FT.	VELOCITY F.P.S.	VOLUME MIL. CU. FT.	PEAK FLOW C.F.S.	TIME OF PEAK HR.	DEPTH FT.	VELOCITY F.P.S.	VOLUME MIL. CU. FT.
A, Down Stream	1524	8.1	6.06	7.56		1824	8.1	6.60	7.92						
B, Branch	746	10.0				946	9.9								
Up Stream	1568	8.2				1890	8.2								
Down Stream	1569	8.2	6.12	7.67		1916	9.7	6.73	8.08						
C, Branch	489	7.2				571	7.2								
Up Stream	1633	8.5				1995	8.5								
Down Stream	1774	7.3	5.92	9.14		2221	7.3	6.58	9.69						
J, Down Stream	590	7.2	4.42	7.28		703	7.2	7.61	4.77						
K, Branch	688	7.3				798	7.2								
Up Stream	1063	7.3				1277	7.3								
Down Stream	1751	7.3	5.98	11.28		2073	7.3	6.49	11.78						
D, Branch	1775	7.4				2107	7.4								
Up Stream	2201	7.5				2828	7.4								
Down Stream	3961	7.4	9.60	9.41		4934	7.4	10.59	9.96						
E, Branch	747	10.2				914	10.1								
Up Stream	3969	7.5				4911	7.5								
Down Stream	3969	7.5	10.54	9.07		4911	7.5	11.58	8.52						
F, Branch	509	7.3				433	7.3								
Up Stream	3963	7.6				4898	7.6								
Down Stream	4345	7.6	13.23	5.99		5228	7.6	14.39	6.28						
G, Down Stream	4357	7.7	9.28	7.46		5234	7.7	10.17	7.84						
M, Down Stream	251	7.2	2.67	9.53		291	7.2	2.84	8.86						
H, Branch	593	7.1				711	7.1								
Up Stream	4281	8.0				5165	7.9								
Down Stream	4434	8.0	8.19	9.17		5366	7.9	8.96	9.66						
L, Down Stream	298	7.3	3.23	6.24		427	7.2	3.80	6.65						
I, Branch	351	7.0				539	7.0								
Down Stream	4485	8.2	6.34	9.54		5476	8.1	7.08	10.13						
Lake	4528	8.2				5532	8.2								

SWM 25:9
CROOKED CREEK

TABLE II-8

Table 11-9

VARIOUS ON-SITE STORM WATER CONTROL METHODS

AREA	REDUCING RUNOFF	DELAYING RUNOFF
Large Flat Roof	1. Cistern storage 2. Rooftop gardens 3. Pool storage or fountain storage	1. Ponding on roof by constricted downspouts 2. Increasing roof roughness a. Rippled roof b. Gravelled roof
Parking Lots	1. Porous pavement a. Gravel parking lots b. Porous or punctured asphalt 2. Concrete vaults and cisterns beneath parking lots in high value areas 3. Vegetated ponding areas around parking lots 4. Gravel trenches	1. Grassy strips on parking lots 2. Grassed waterways draining parking lot 3. Ponding and detention measures for impervious areas a. Rippled pavement b. Depressions c. Basins
Residential	1. Cisterns for individual homes or groups of homes 2. Gravel driveways (porous) 3. Contoured landscape 4. Ground-water recharge a. Perforated pipe b. Gravel (sand) c. Trench d. Porous pipe e. Dry wells 5. Vegetated depressions	1. Reservoir of detention basin 2. Planting a high delaying grass (high roughness) 3. Gravel driveways 4. Grassy gutters or channels 5. Increased length of travel of runoff by means of gutters, diversions, etc.
General	1. Gravel alleys 2. Porous sidewalks 3. Mulched planters	1. Gravel alleys

Source: Urban Hydrology for Small Watersheds.
Technical Release No. 55

Table 11-10

ADVANTAGES AND DISADVANTAGES OF VARIOUS ON-SITE STORM WATER CONTROL METHODS

MEASURE	ADVANTAGES	DISADVANTAGES
A. Cisterns and Covered Ponds	1. Water may be used for: a. Fire Protection b. Watering lawns c. Industrial processes d. Cooling purposes 2. Reduce runoff while only occupying small area 3. Land or space above cistern may be used for other purposes	1. Expensive to install 2. Cost required may be restrictive if the cistern must accept water from large drainage areas 3. Requires slight maintenance 4. Restricted access 5. Reduces available space in basements for other uses
B. Rooftop Gardens	1. Esthetically pleasing 2. Runoff reduction 3. Reduce noise levels 4. Wildlife enhancement	1. Higher structural loadings on roof and building 2. Expensive to install and maintain
C. Surface Pond Storage (usually residential areas)	1. Controls large drainage areas with low release 2. Esthetically pleasing 3. Possible recreation benefits a. Boating b. Ice skating c. Fishing d. Swimming 4. Aquatic life habitat 5. Increases land value of adjoining property	1. Requires large areas 2. Possible pollution from storm water and siltation 3. Possible mosquito breeding areas 4. May have adverse algal blooms as a result of eutrophication 5. Possible drowning 6. Maintenance problems

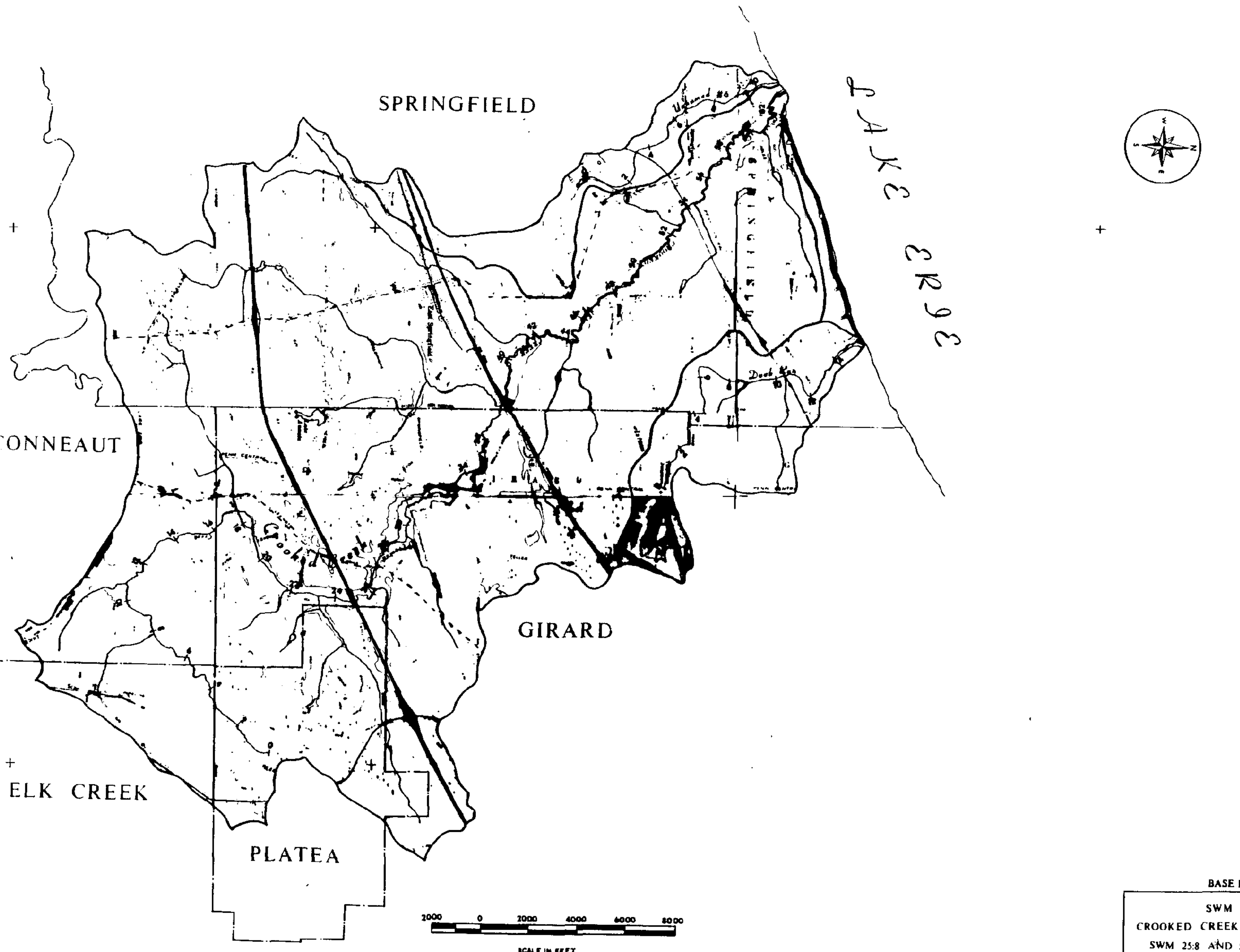
Table 11-10 (Continued)

D. Ponding on Roof by Constricted Downspouts	1. Runoff delay 2. Cooling effect for building a. Water on roof b. Circulation through 3. Roof ponding provides fire protection for building (roof water may be trapped in case of fire)	1. Higher structural loadings 2. Clogging of constricted inlet requiring maintenance 3. Freezing during winter (expansion) 4. Waves and wave loading 5. Leakage of roof water into building (water damage)
E. Increased Roof Roughness a. Rippled roof b. Gravel on roof	1. Runoff delay and some reduction (detention in ripples or gravel)	1. Somewhat higher structural loadings
F. Porous pavement (parking lots and alleys) a. Gravel parking lot b. Holes in impervious pavements (¼ in. diam.) filled with sand	1. Runoff reduction (a and b) 2. Potential groundwater recharge (a and b) 3. Gravel pavements may be cheaper than asphalt or concrete (a)	1. Clogging of holes or gravel pores (a and b) 2. Compaction of earth below pavement or gravel decreases permeability of soil (a and b) 3. Ground-water pollution from salt in winter (a and b) 4. Frost heaving for impervious pavement with holes (b) 5. Difficult to maintain 6. Grass or weeds could grow in porous pavement (a and b)
G. Grassed channels and vegetated strips	1. Runoff delay 2. Some runoff reduction (infiltration recharge 3. Esthetically pleasing a. Flowers b. Trees	1. Sacrifice some land area for vegetated strips 2. Grassed areas must be mowed or cut periodically (maintenance costs)

Table 11-10(Continued)

H. Ponding and detention measures on impervious pavement a. Rippled pavement b. Basins c. Constructed inlets	1. Runoff delay (a, b, and c) 2. Runoff reduction (a and b)	1. Somewhat restricted movement of vehicle (a) 2. Interferes with normal use (a and c) 3. Damage to rippled pavement during snow removal (a) 4. Depressions collect dirt and debris (a, b, and c)
I. Reservoir or detention basin	1. Runoff delay 2. Recreation benefits a. Ice Skating b. Baseball, football, etc. if land is provided 3. Esthetically pleasing 4. Could control large drainage areas with low release	1. Considerable amount of land is necessary 2. Maintenance costs a. Mowing grass b. Herbicides c. Cleaning periodically (silt removal) 3. Mosquito breeding area 4. Siltation in basin
J. Converted septic tank for storage and ground-water recharge	1. Low installation costs 2. Runoff reduction (infiltration and storage) 3. Water may be used for: a. Fire protection b. Watering lawns and gardens c. Ground-water recharge	1. Requires periodic maintenance (silt removal) 2. Possible health hazard 3. Sometimes requires a pump for emptying after storm
K. Ground-water recharge a. Perforated pipe or hose b. French drain c. Porous pipe d. Dry well	1. Runoff reduction (infiltration) 2. Ground-water recharge with relatively clean water 3. May supply water to garden or dry areas 4. Little evaporation loss	1. Clogging of pores or perforated pipe 2. Initial expense of installation (materials)
L. High delay grass (high roughness)	1. Runoff delay 2. Increased infiltration	1. Possible erosion or scour 2. Standing water on lawn in depressions

Source: Urban Hydrology for Small Watershed
Technical Release No. 55



BASE MAP

SWM 25:9

CROOKED CREEK WATERSHED

SWM 25:8 AND SWM 25:10

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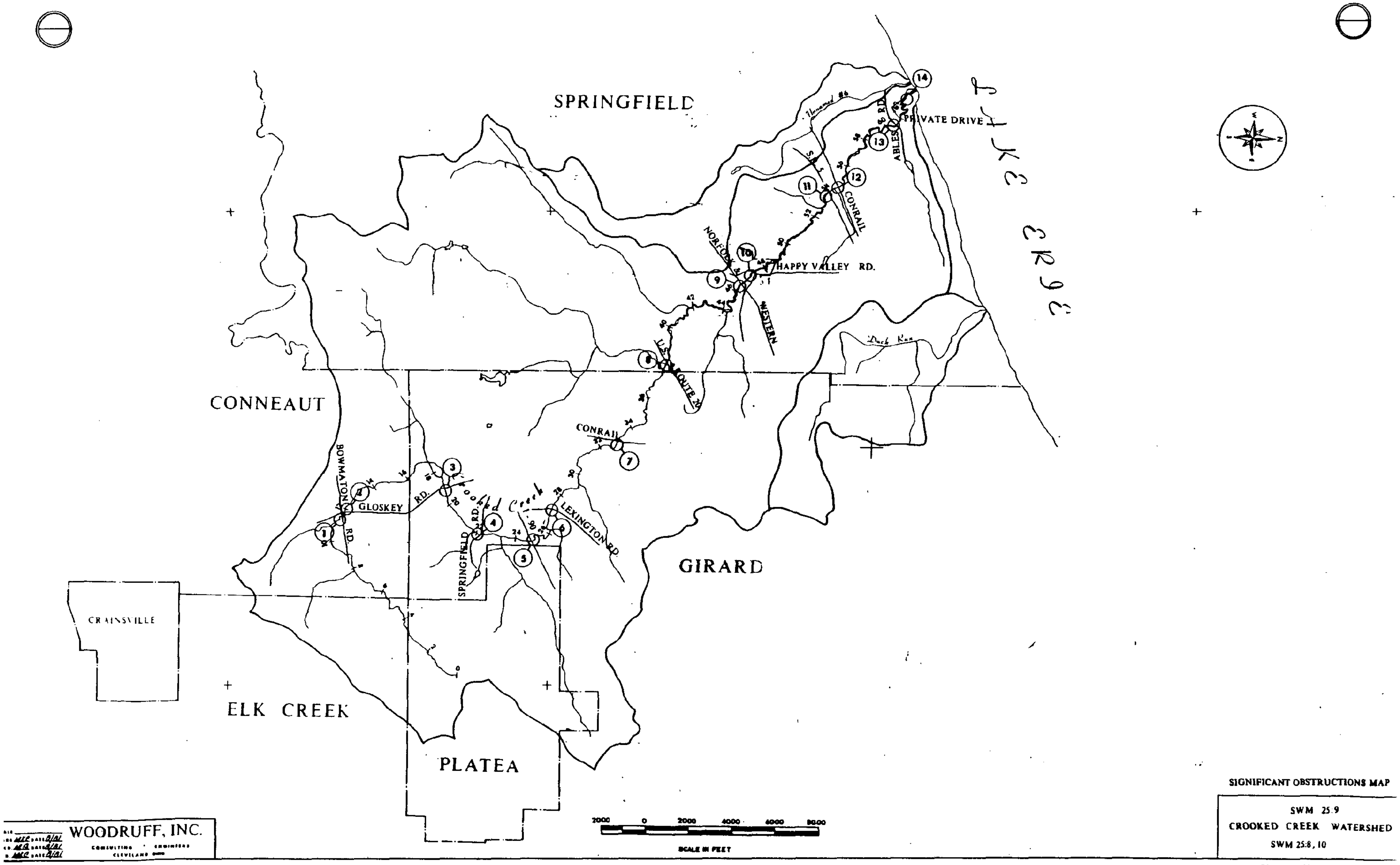
CLEVELAND OHIO

MADE CWH DATE 6/81

CKD MKC DATE 6/81

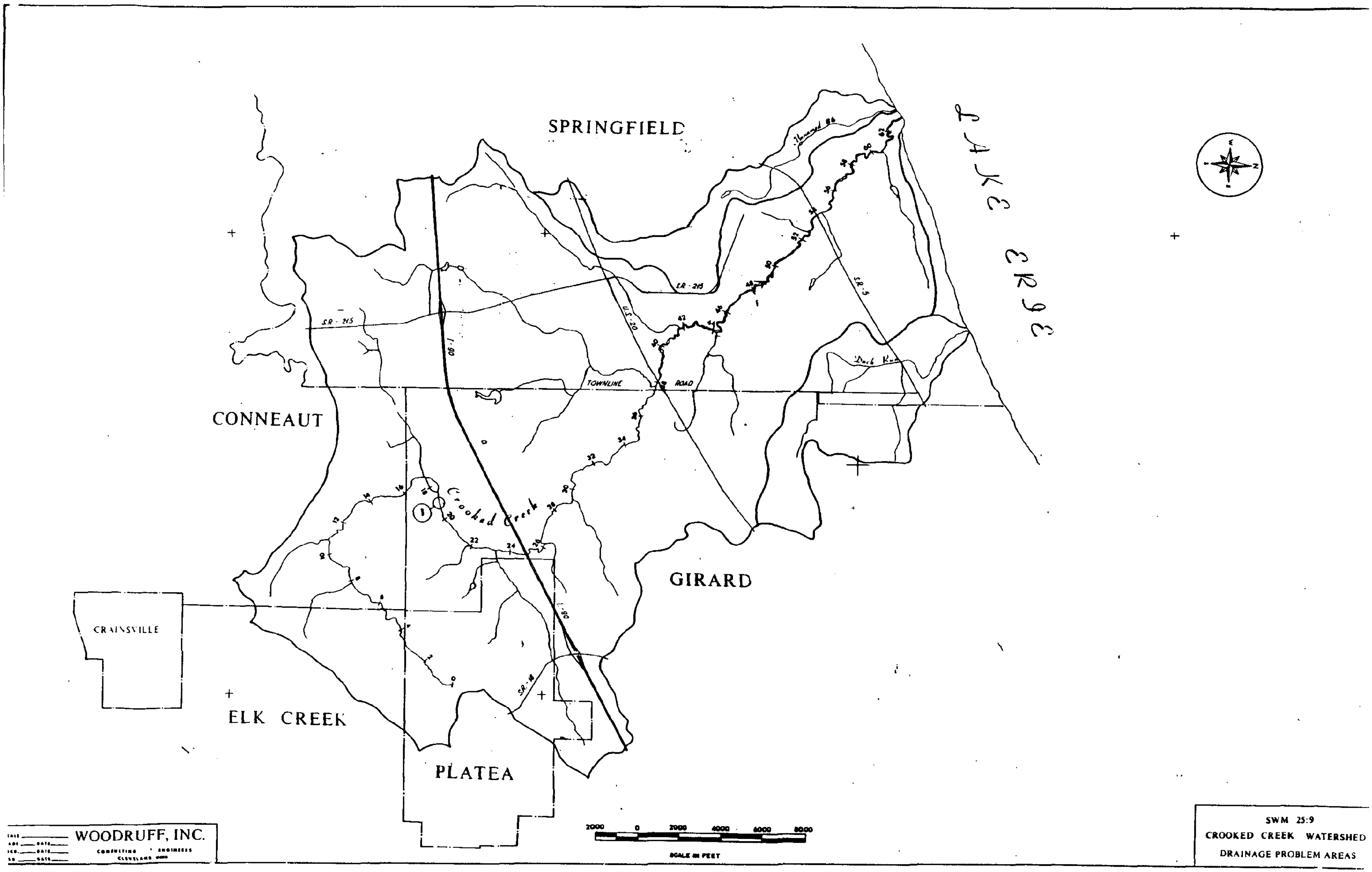


SIGNIFICANT OBSTRUCTIONS MAP

SWM 25.9

CROOKED CREEK WATERSHED

SWM 25:8, 10


LAKE ERIE
SPRINGFIELD
CONNEAUT
GIRARD
ELK CREEK
PLATEA
CRAINSVILLE
Crooked Creek
Duck Run
S.R. 215
S.R. 5
U.S. 20
I-90
S.R. 18
TOWNLINE ROAD
2000 0 2000 4000 6000 8000
SCALE IN FEET
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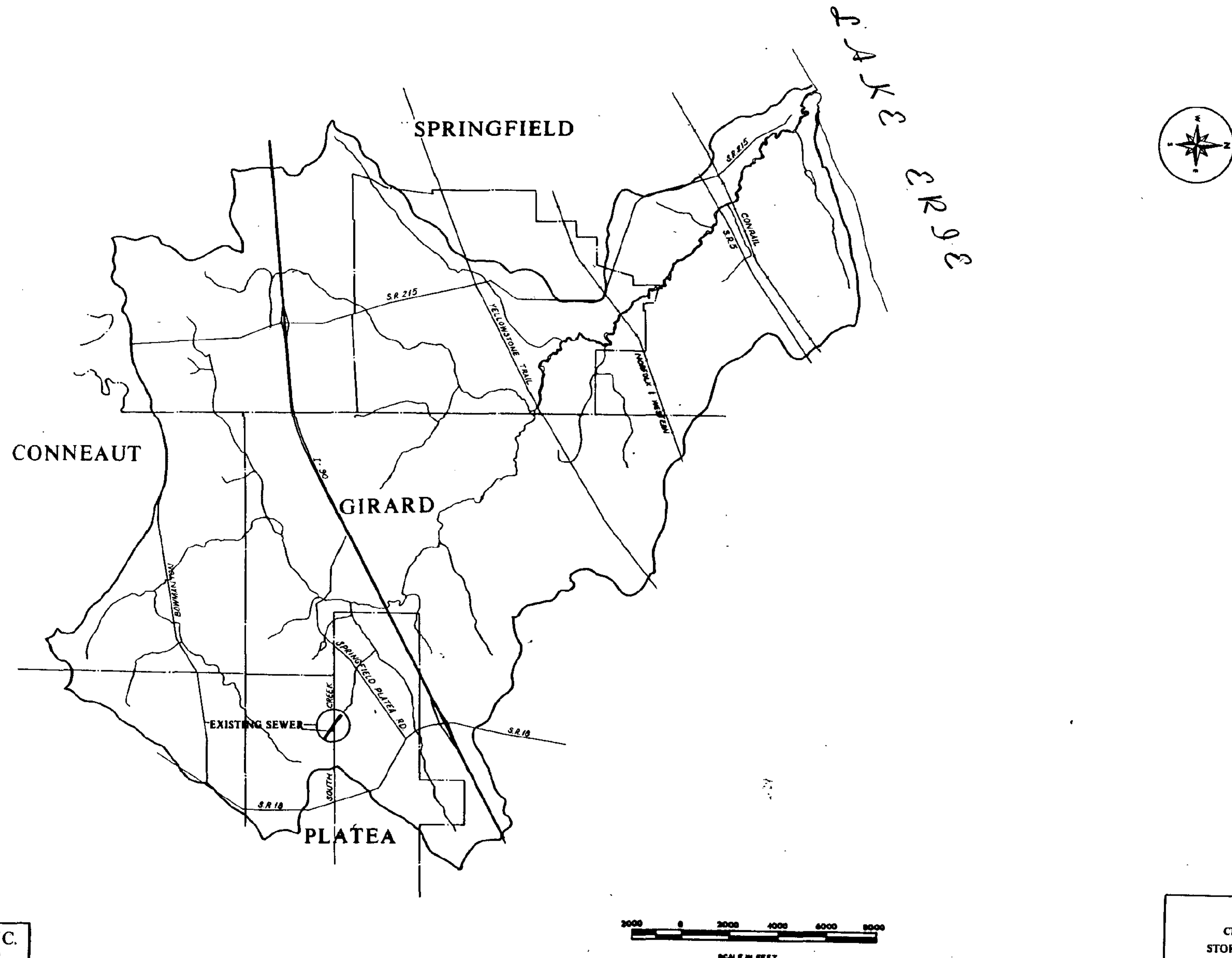
SWM 25:9
CROOKED CREEK WATERSHED
DRAINAGE PROBLEM AREAS



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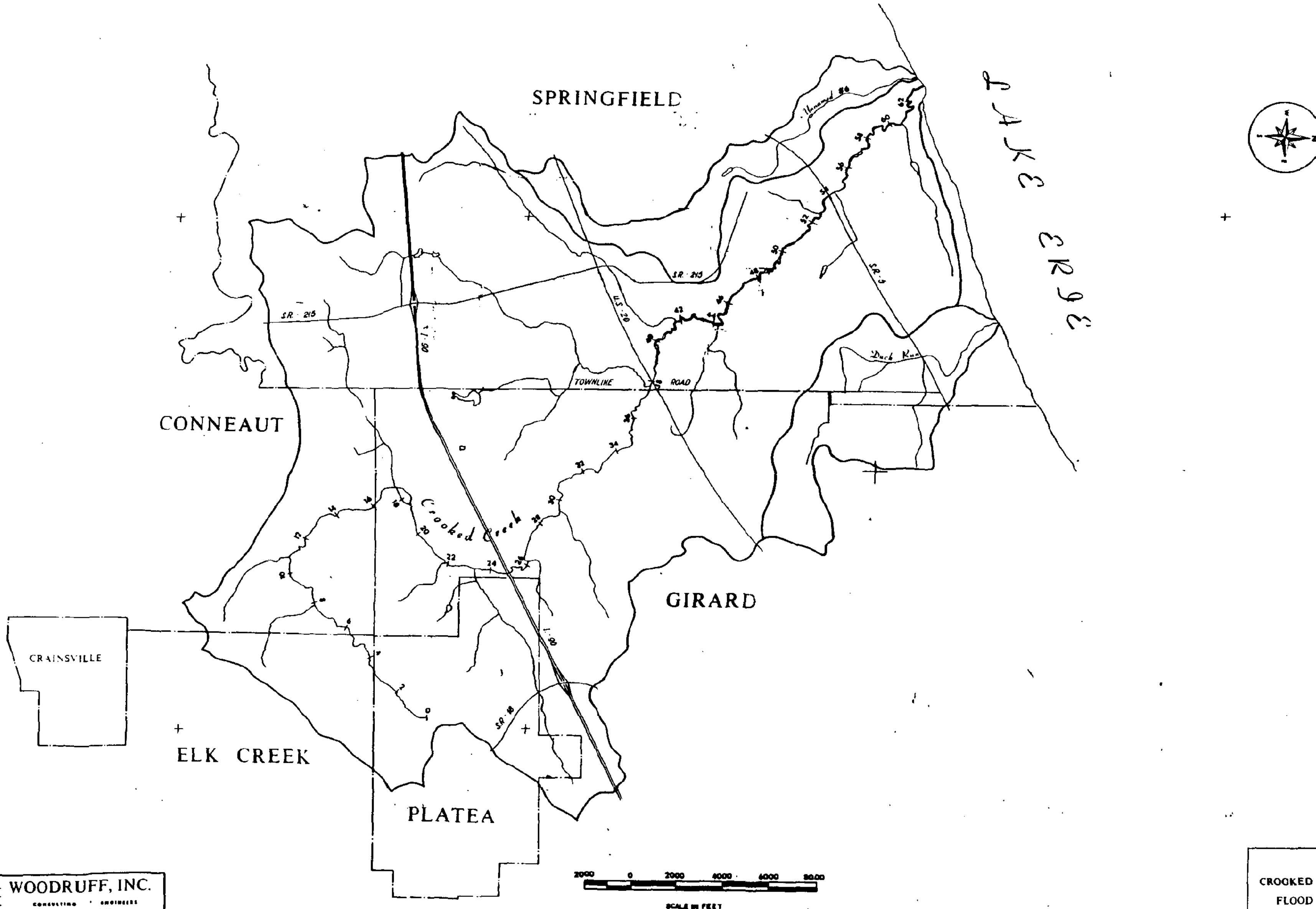
SWM 259
CROOKED CREEK
STORM SEWER SYSTEMS



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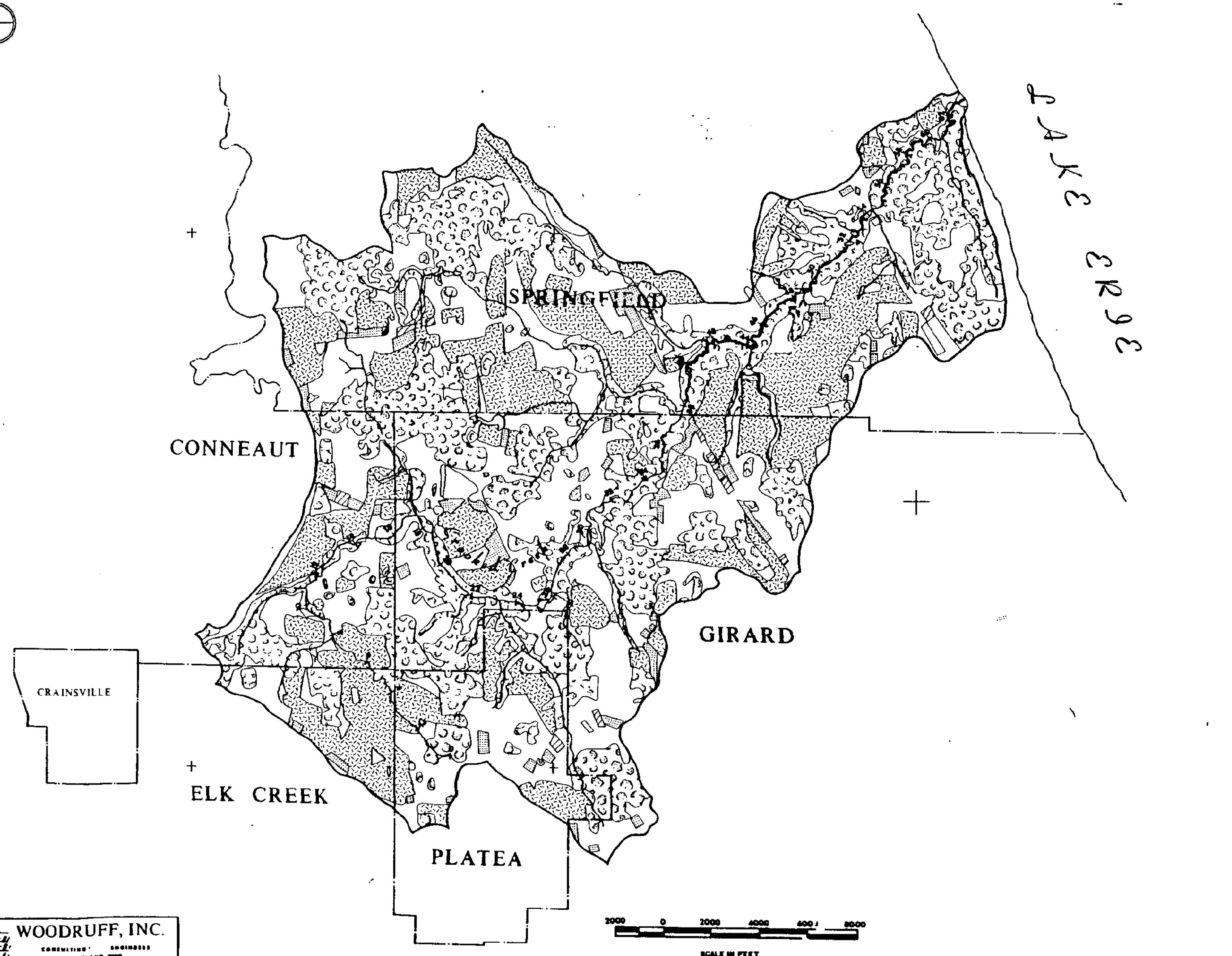
SWM 25:9
CROOKED CREEK WATERSHED
FLOOD CONTROL PROJECTS
PLATE NUMBER II-5



SUBWATERSHED	WEIGHTED CN FOR EXISTING LAND USE
NUMBER	
1	74.15
2	67.63
3	71.48
4	75.77
5	77.50
6	76.78
7	74.39
8	74.44
9	63.94
10	65.56
11	62.33
12	71.37
13	72.49
14	62.49
15	67.69
16	68.51
17	64.77
18	75.25
19	72.66
20	72.51
21	73.67

EXISTING LAND USE LEGEND

- OPEN
- WOODED
- CULTIVATED
- RESIDENTIAL
- COMMERCIAL
- INDUSTRIAL

SWM 25:9
CROOKED CREEK WATERSHED
EXISTING LAND USE

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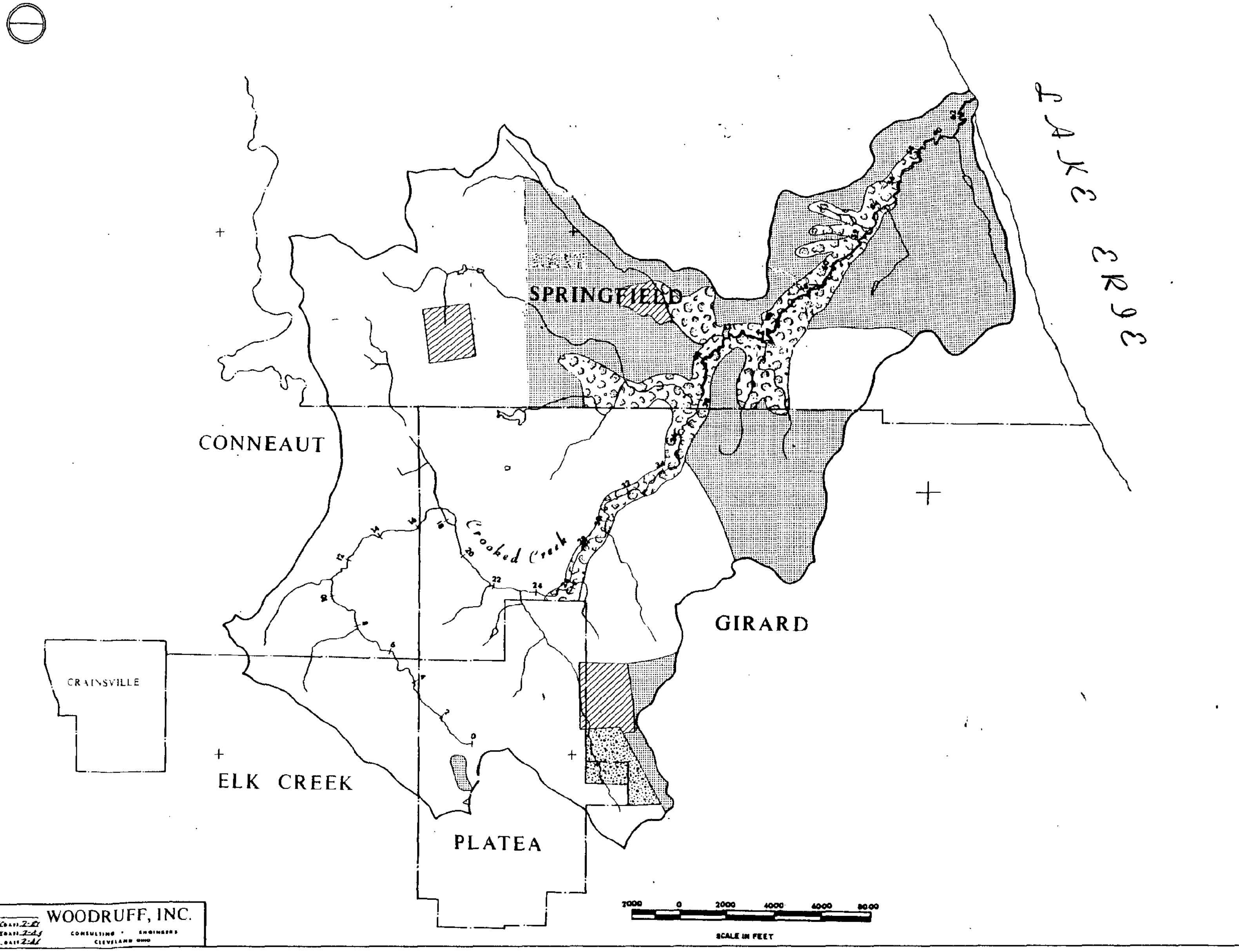

SUBWATERSHED NUMBER	WEIGHTED CN FOR ULTIMATE LAND USE
1	78.28
2	75.10
3	77.96
4	79.66
5	81.68
6	81.97
7	78.98
8	78.24
9	62.91
10	71.61
11	63.19
12	75.75
13	69.01
14	62.40
15	66.69
16	71.66
17	66.15
18	81.36
19	82.11
20	82.11
21	80.84

ULTIMATE LAND USE LEGEND

- RESIDENTIAL - AGRICULTURAL
- WOODED
- RESIDENTIAL
- COMMERCIAL
- INDUSTRIAL

SWM 25:9
CROOKED CREEK WATERSHED
ULTIMATE LAND USE

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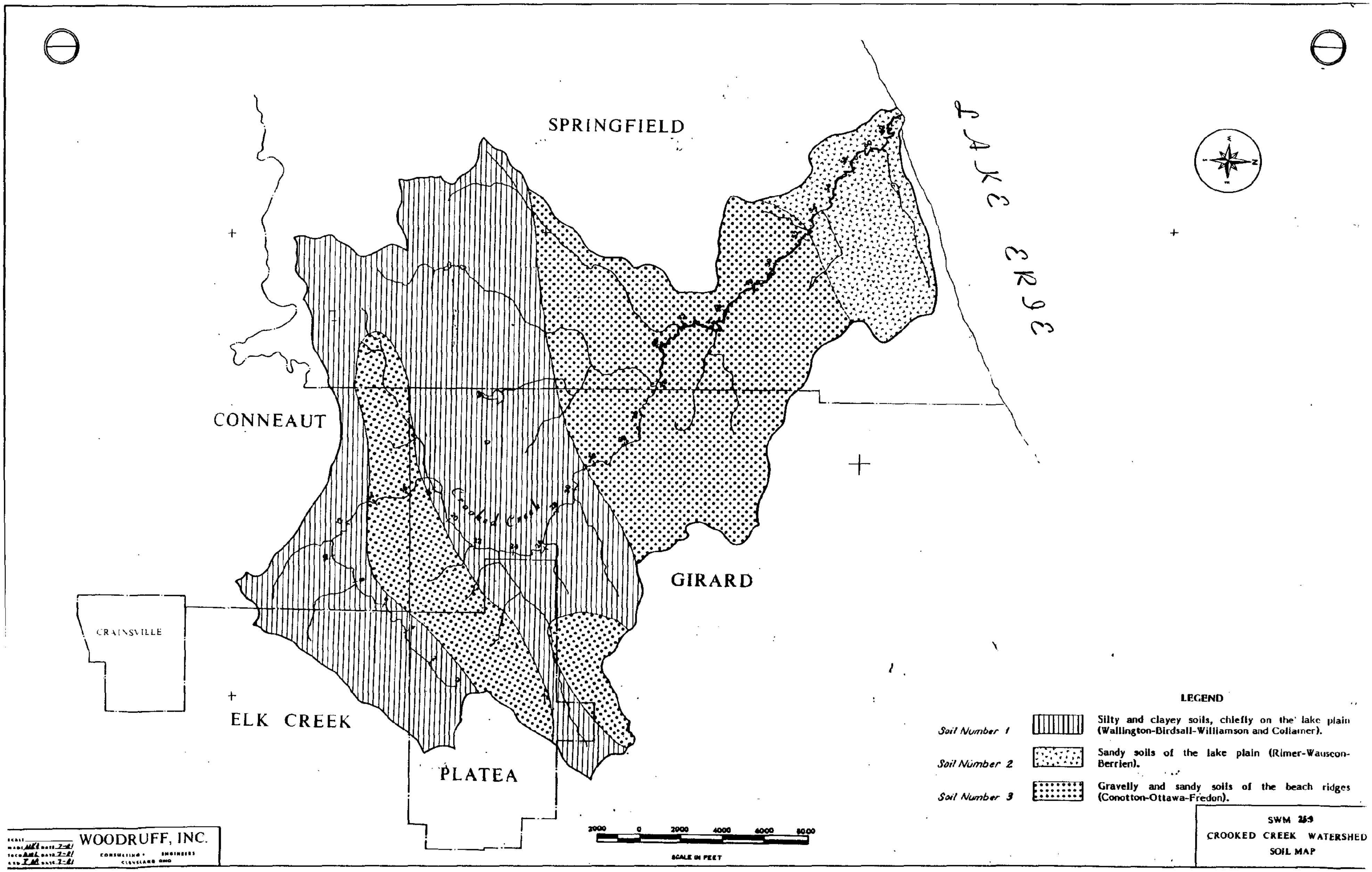
SPRINGFIELD
LAKE ERIE
CONNEAUT
Crooked Creek
GIRARD
CRAINSVILLE
ELK CREEK
PLATEA
LEGEND
Soil Number 1 — Silty and clayey soils, chiefly on the lake plain (Wallington-Birdsall-Williamson and Collamer).
Soil Number 2 — Sandy soils of the lake plain (Rimer-Wauseon-Berrien).
Soil Number 3 — Gravelly and sandy soils of the beach ridges (Conotton-Ottawa-Fredon).
2000 0 2000 4000 6000 8000
SCALE IN FEET
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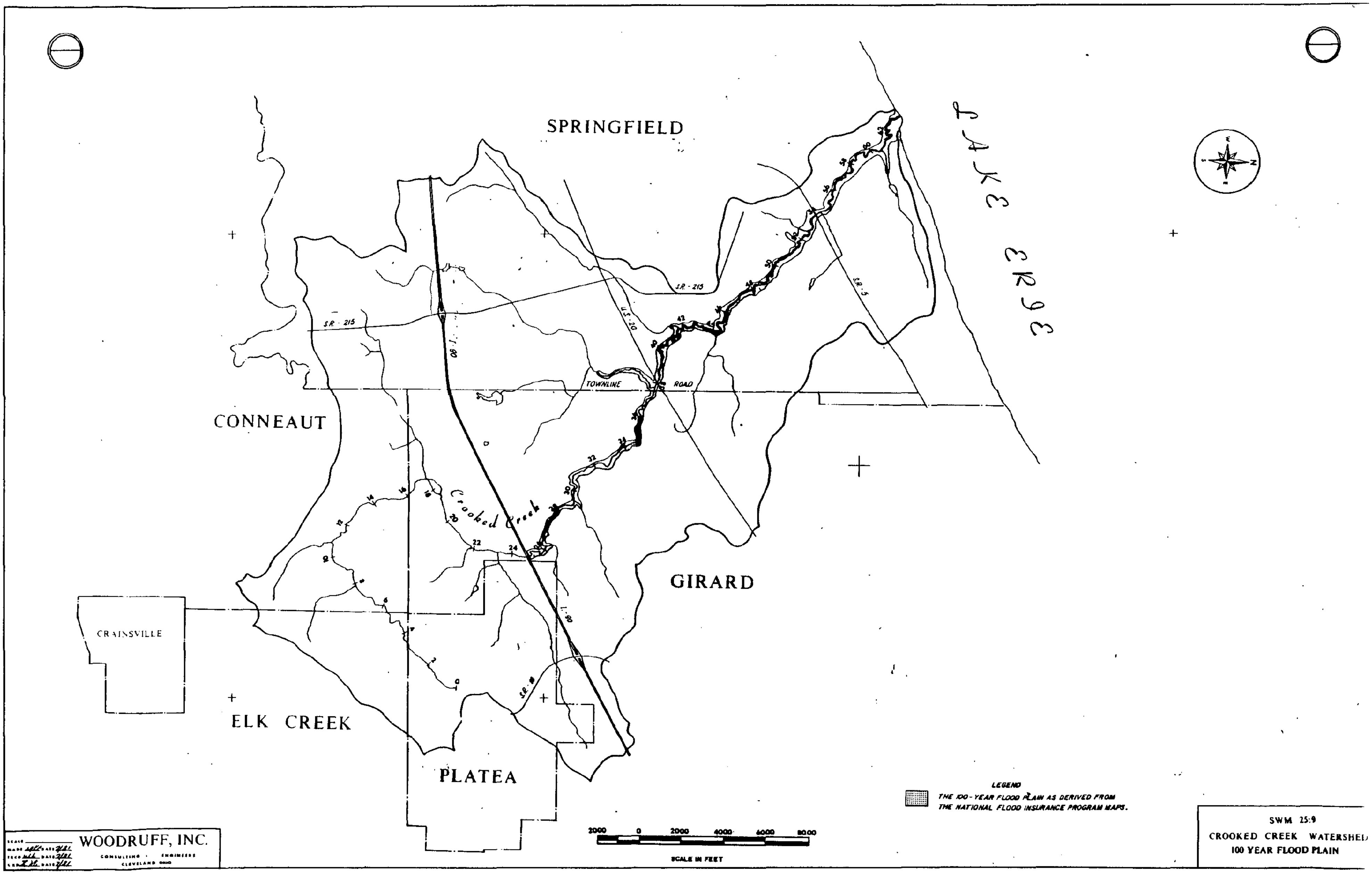
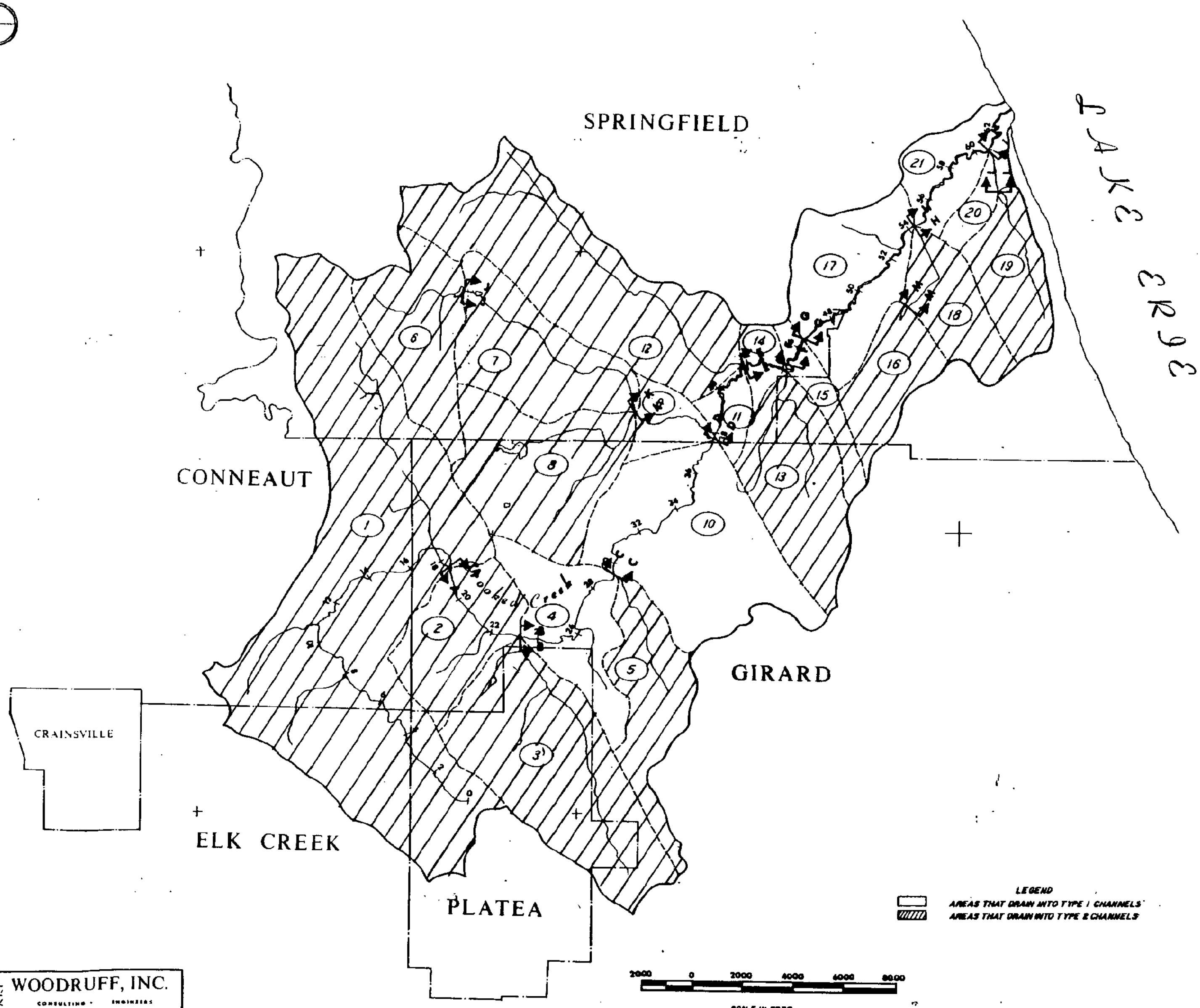
SWM 259
CROOKED CREEK WATERSHED
SOIL MAP



SWM 25:9
CROOKED CREEK WATERSHED
100 YEAR FLOOD PLAIN

PLATE NUMBER II-9



NOTE: THE SYMBOL BELOW IS USED TO LOCATE THE DATA POINTS LISTED ON THE WATERSHED RUNOFF DATA CHART (TABLE II -B).

SUBWATERSHED	AREA	TIME OF CONCENTRATION
NUMBER	ACRES	MINUTES
1	2995.57	132.60
2	463.23	29.70
3	1080.53	68.27
4	480.60	37.35
5	478.20	51.18
6	547.92	45.33
7	615.25	56.18
8	759.12	56.60
9	155.13	26.35
10	1055.60	44.22
11	118.77	24.99
12	1251.35	92.20
13	608.42	56.56
14	101.32	21.80
15	157.34	44.12
16	331.94	42.47
17	615.86	47.70
18	333.55	30.79
19	352.63	51.48
20	107.44	2.05
21	297.86	47.52
TOTAL WATERSHED AREA IN ACRES 12,907.63		

LEGEND

AREAS THAT DRAIN INTO TYPE I CHANNELS

AREAS THAT DRAIN INTO TYPE II CHANNELS

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SWM 259
CROOKED CREEK WATERSHED
SUBWATERSHED MAP

APPENDIX B

Calculations To Determine Increased Runoff

And

Examples Of Specific On-Site Storage

APPENDIX B

CALCULATIONS TO DETERMINE INCREASED RUNOFF AND EXAMPLES OF SPECIFIC ON-SITE STORAGE

The procedures presented in this appendix are applicable to all unit developments which contain between 2500 square feet and 43,560 square feet of impervious surface area. Those exempt cases discussed in the text need not make the following calculations. Developments with more than 43,560 square feet of impervious surface area must consult a qualified professional person to aid in determining their excess storm water runoff volume.

By following these methods, the non-technical individual can easily determine the amount of excess storm water runoff which he is required to manage. The methods of control presented in this study, or any other approved innovative methods, may be used to manage this calculated runoff volume.

Excess Storm Water Runoff Calculation Procedure

Step 1 Determine dimensions of proposed buildings, drives, patios or other impervious areas. These can usually be found on building site plans.

Step 2 Calculate impervious area. The more common shapes that will be encountered are rectangles, triangles or circles. Equations to calculate the areas of these shapes are as follows: (all dimensions are assumed to be in feet)

i) Rectangle: area (sq. ft.) = length (ft.) x width (ft.)

ii) Triangle: area (sq. ft.) = 1/2 x base (ft.) x height (ft.)

iii) Circle: area (sq. ft.) = 0.785 x diameter^2 (ft.)

Step 3 Refer to Section 4.2 and plate of volume describing the watershed in which construction is to take place. If construction is found to be along a Type 1 channel, then use Type 1 criteria. All others use Type 2 criteria.

Step 4 Use Figure B-1 to find excess runoff volume to be managed.

Example: Figure B-2 shows a typical site plan for proposed residential lot located along a Type 1 Channel. Determine the amount of excess runoff volume required to be managed.

(1) Dimensions as shown on Figure B-2.

(2) Impervious Area:

(a) Drive: 14' x 70' = 980 sq. ft.

(b) House: 40' x 80' = 3200 sq. ft.

(c) Patio: 1/2' x 20' x 20' = 400 sq. ft.

Total Impervious Area 6180 sq. ft.

(3.) Type 1 criteria as given.

(4.) From Figure B-1, excess runoff volume to be managed is 1150 cubic feet.

Note: One acre contains 43,560 sq. ft. One cubic foot contains 7.48 gallons of water.

FIGURE B -1

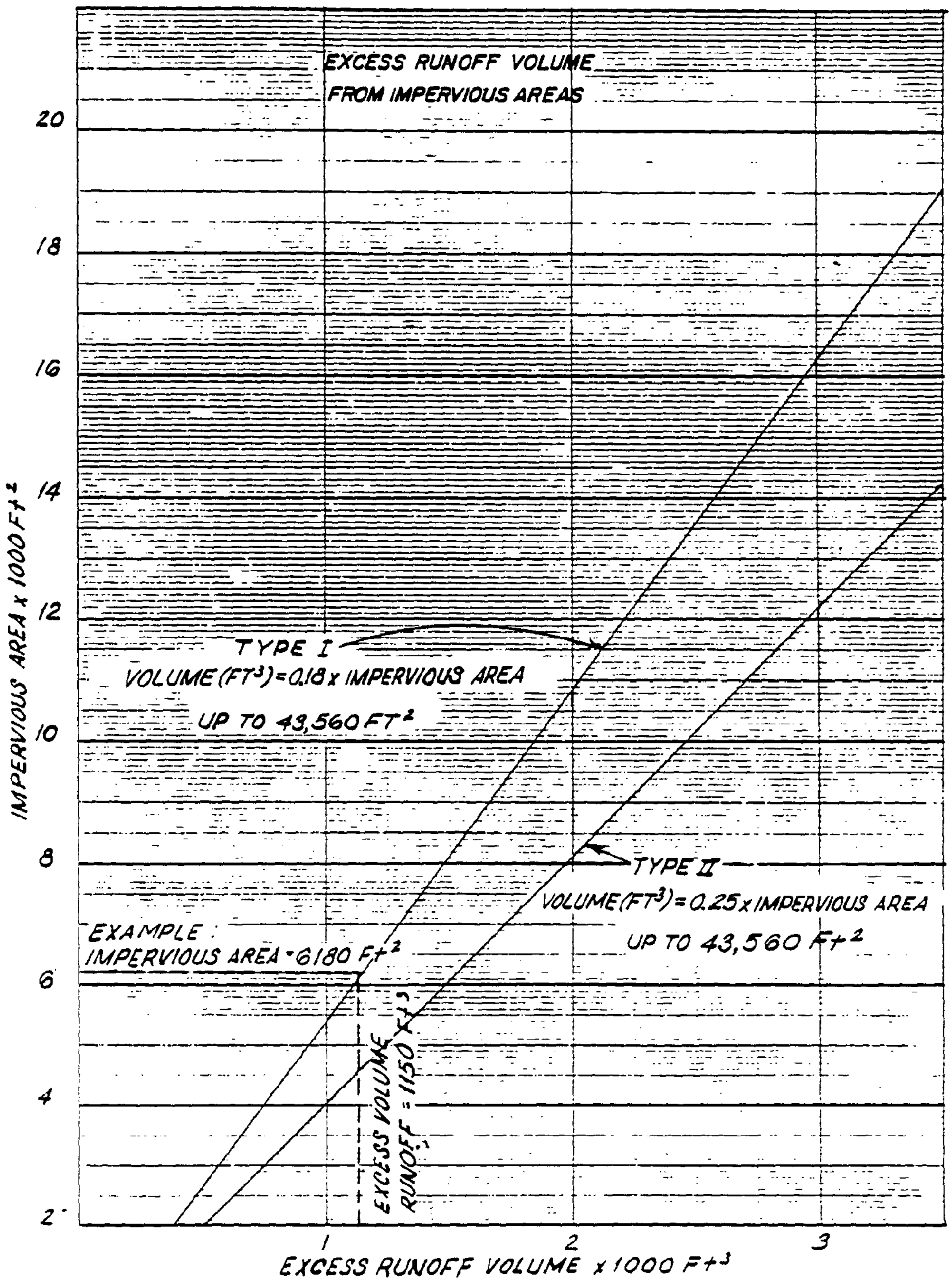
EXCESS RUNOFF VOLUME
FROM IMPERVIOUS AREAS
TYPE I
VOLUME(FT³)=0.18 x IMPERVIOUS AREA
UP TO 43,560 FT²
TYPE II
VOLUME(FT³)=0.25 x IMPERVIOUS AREA
UP TO 43,560 Ft²
EXAMPLE :
IMPERVIOUS AREA = 6180 Ft²
EXCESS VOLUME
RUNOFF = 1150 Ft³
IMPERVIOUS AREA x 1000 Ft²
EXCESS RUNOFF VOLUME x 1000 Ft³
20
18
16
14
12
10
8
6
4
2
1
2
3

FIGURE B-2
TYPICAL RESIDENTIAL SITE PLAN

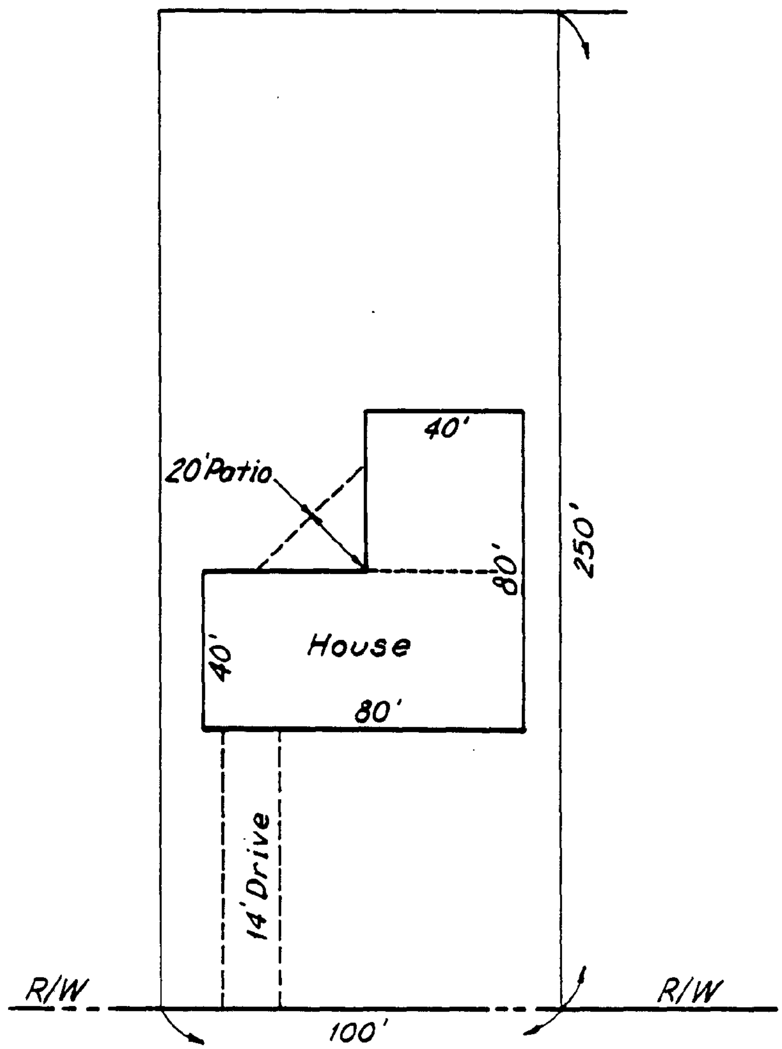

FIGURE B-3
ON-SITE STORM WATER MANAGEMENT
ALTERNATE NO. 1
SURFACE STORAGE

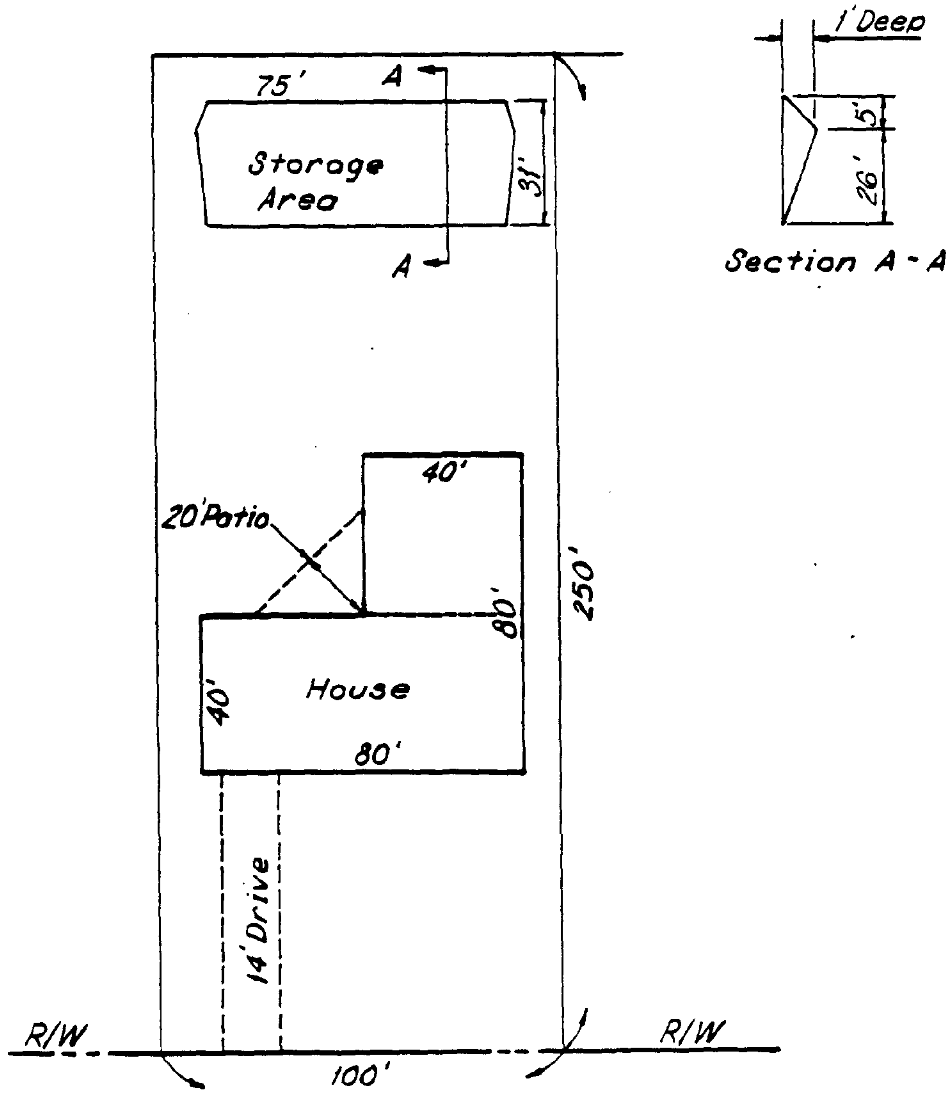

FIGURE B-4
ON-SITE STORM WATER MANAGEMENT
ALTERNATE NO. 2
OVERSIZED STORM SEWER PIPE

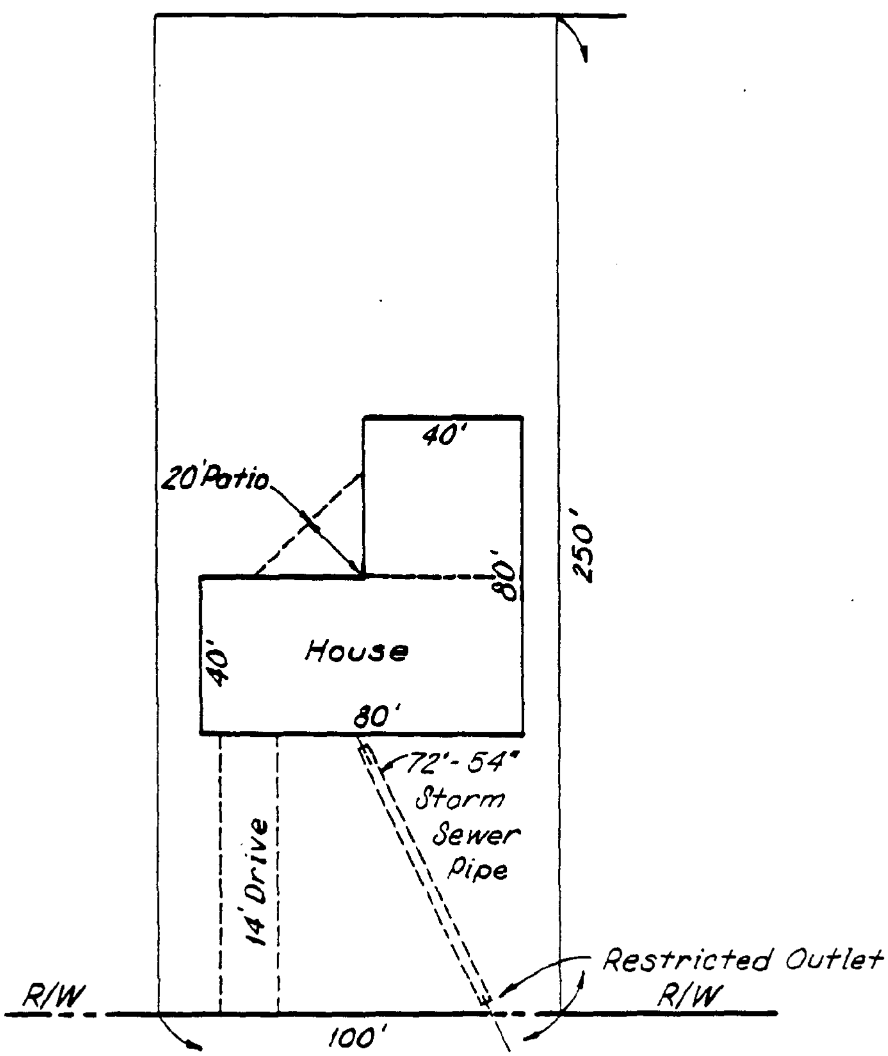

FIGURE B-5

ON-SITE STORM WATER MANAGEMENT

ALTERNATE NO.3

POND STORAGE

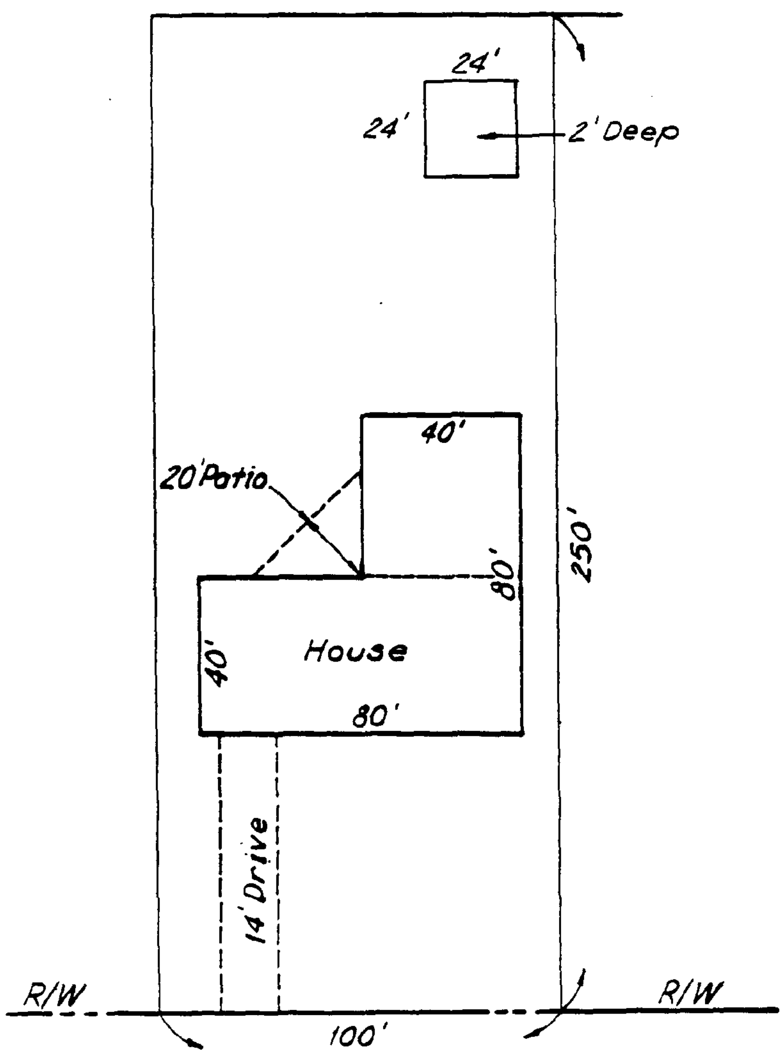

FIGURE B-6
ON-SITE STORM WATER MANAGEMENT
ALTERNATE NO. 4
UNDERGROUND TANK STORAGE